

Magnetostratigraphy and Magnetic Mineralogy of the Ludlow Member of the Fort Union Formation (Lower Paleocene) of the Williston Basin in North Dakota

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A continuous succession of Cretaceous through lowermost Eocene terrestrial sediments contains a nearly complete Paleocene record, in the Little Missouri River Valley of North Dakota, USA. We aim to calibrate the rates of post-Cretaceous ecological recovery from mass extinction, by determining a detailed chronostratigraphy of plant and mammal fossils in the basin. Using the Cretaceous-Paleogene (K-T) boundary as the basal datum, we have constructed a ca.300 meter composite section of the Upper Cretaceous Hell Creek Formation and the Lower Paleocene Ludlow Member of the Fort Union Formation.

We analyzed paleomagnetic samples from 12 stratigraphic sections using a combined low-AF and thermal demagnetization strategy. Instability of magnetization above 200 °C has been reported in previous studies, which we reproduced when heating in air; however, when the samples were heated in nitrogen the stability field extended to well above 300 °C. The analyzed samples demonstrate a series of geomagnetic reversals that can be correlated from C29n through C27r of the Geomagnetic Polarity Time Scale (GPTS).

Bulk susceptibility vs. temperature studies on sandstone, siltstone, and carbonaceous shale indicate predominately irreversible curves suggesting titanomaghemite as the magnetic carrier in the Ludlow Member sediments. IRM acquisition in our samples consistently shows non-saturation above 100 mT indicating an additional anti-ferromagnetic component, most likely goethite.

The dominant iron oxide in these samples, titanomaghemite, was generated either during weathering of the source terrain during Laramide uplift, or weathered in-situ prior to diagenesis, or during alteration after burial. We infer that the magnetization of the samples is primary because the polarity direction is consistent with that of the Paleocene of North America and the reversal stratigraphy from this section corresponds to the GPTS with reasonable sedimentation rates.

Our results imply a temporal restriction of the Puercan North American land mammal age subzones Pu1 and Pu2 in the Williston Basin from ~1 Myr, as previously considered, to ~250 kyr, which suggests that post-extinction mammal speciation occurred more rapidly than previously supposed.